
Space Weather Technical Forecast

Issued on Friday, 29 March 2024 at 00:41 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: M-flares (R1/R2 blackout) expected, slight chance of further X-flares (R3 blackout). Electron Fluence likely rising above the Active threshold.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been High with the largest flare X1.1 peaking at 28/2056 UTC from AR3615. This region has also produced 3 M-flares in the last 24 hours. There are now four sunspot regions on the visible disc, with one region having faded. AR3615 is by far the largest and most magnetically complex group, with at least one delta spot, but it is becoming more difficult to assess as it approaches the limb. All remaining spots are comparatively small and simple.

The recent X1.1 flare appeared to produce a CME directed towards the southwest in the latest coronagraph imagery. This is yet to be assessed, but is currently thought unlikely to have a significant Earth directed component. Otherwise, no significant Earth-directed CMEs were observed over the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind at L1, as measured by ACE, has been mostly at slightly elevated levels as the CME effects from last weekend continue to decline. Wind speeds eased from around 470 km/s to near 400 km/s. The density has been below average. The Interplanetary Magnetic Field, Bt, was weak below 5nT. The north-south component, Bz, fluctuated weakly between +4/-2nT. The phi angle was mostly positive (away from the Sun), but has recently rotated to become negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: Solar radiation was well below the S1 threshold, but still a little above background levels with a slow declining trend evident. High energy electron flux (greater than 2MeV) observed at GOES16 was mostly at background levels. The observed 24-hour fluence was well below the Active threshold, on a fairly steady trend, with a value at 29/0000UTC of 5.46e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: M-class flare activity is expected, with a slight chance of further isolated X-class flares, most likely from AR3615. This risk then declines through Day 3 (31 Mar) as AR3615 rotates away from the limb.

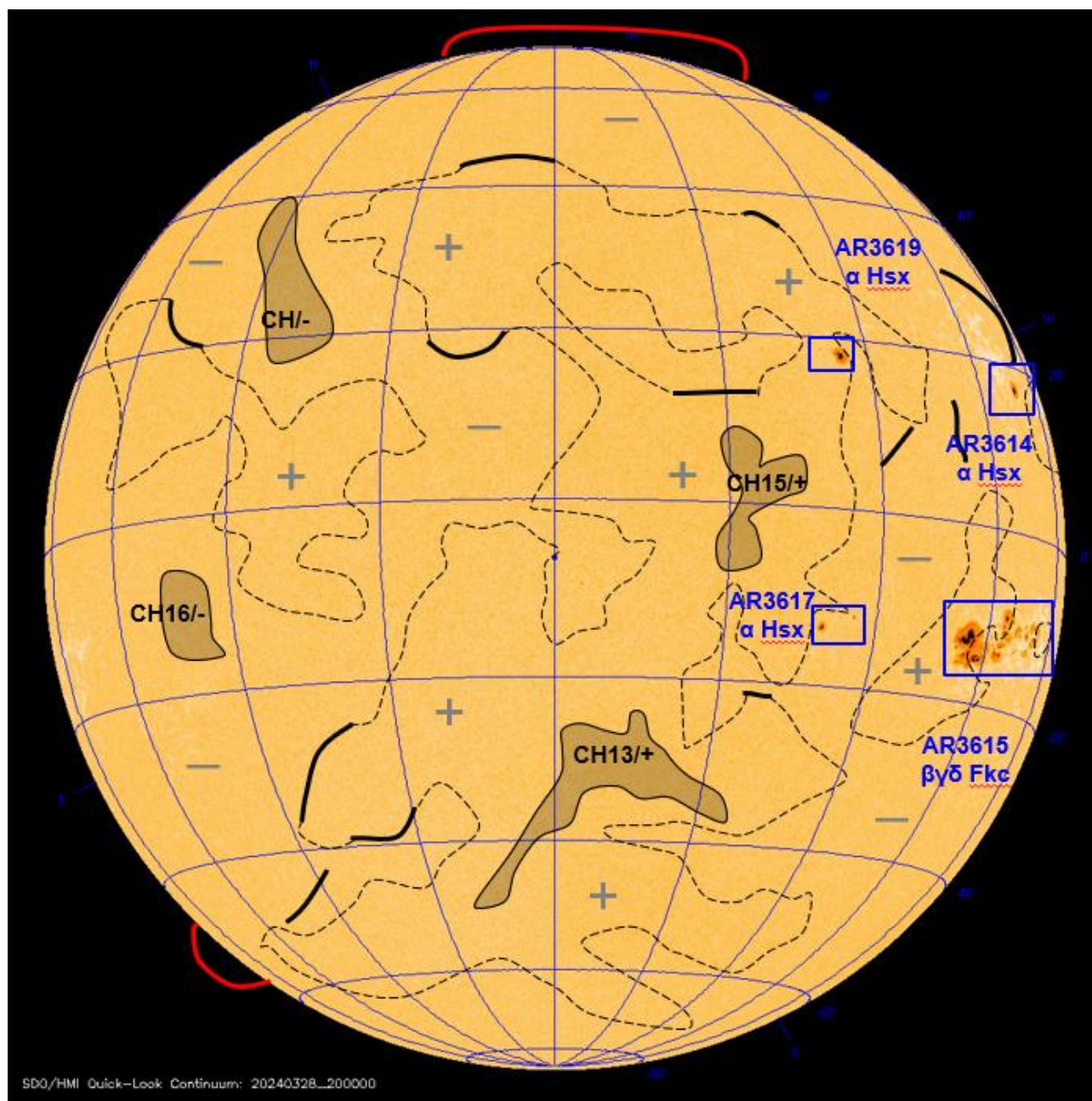
Solar Wind / Geomagnetic Activity: There are currently no significant Earth-directed CMEs forecast to arrive in the next four days. Solar winds have been at slightly elevated levels, but are showing a slow decline towards background levels, which is expected to continue as recent CME effects continue to wane. Connection to a High Speed Stream (HSS) from CH15/+ is possible later Day 2 into Day 3 (30-31 Mar), with speeds of around 450-500 km/s most likely. Generally Quiet to Unsettled geomagnetic activity is expected through the period, perhaps with a slight chance of Active intervals when the HSS arrives.

Energetic Particles / Solar Radiation: High energy proton flux, as observed by GOES18, is now near background levels after the recent enhancement. There is a slight chance of further

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

enhancement due to larger flares, mainly from AR3615.
 High energy electron flux (greater than 2MeV) is likely to become enhanced following the elevated solar winds, with a sharp increase to high levels probable in the next couple of days.
 The associated 24-hour fluence is likely to show a sharp increase to Active ($1e8$ integrated pfu).

Figure 1. Solar Analysis Valid 28/2000 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There are currently no significant Earth-directed CMEs forecast to arrive in the next four days.

Solar winds have been at slightly elevated levels in the aftermath of the CME which arrived at Earth last weekend. Wind speeds are showing a slow decline towards background levels, which is expected to continue as the CME effects continue to wane. Connection to a High Speed Stream (HSS) from CH15/+ is possible later Day 2 into Day 3 (30-31 Mar), but as this feature wasn't present on the last rotation it is difficult to judge how much of a wind speed increase we might experience. It is a small feature, so speeds of around 450-500 km/s seem most likely. However, it is positive polarity which is not favoured for a geomagnetic response at this time of year.

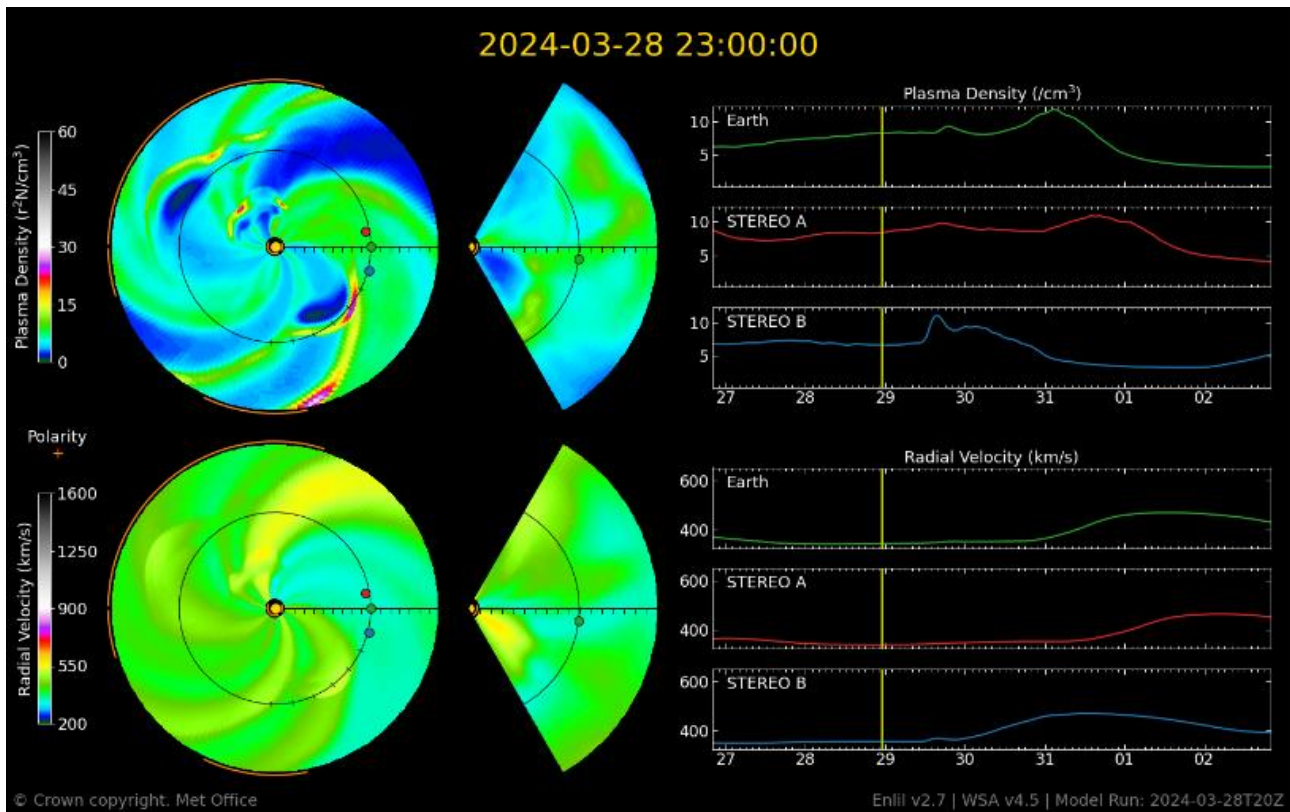
Generally Quiet to Unsettled geomagnetic activity is expected through the guidance period in the absence of any further CME enhancements, perhaps with a slight chance of Active intervals when the HSS arrives.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth directed CMEs are currently expected.

Figure 2: MOSWOC Enlil showing a possible HSS to around 500 km/s during 31 March.



Radio Blackouts - X-Ray Flares:

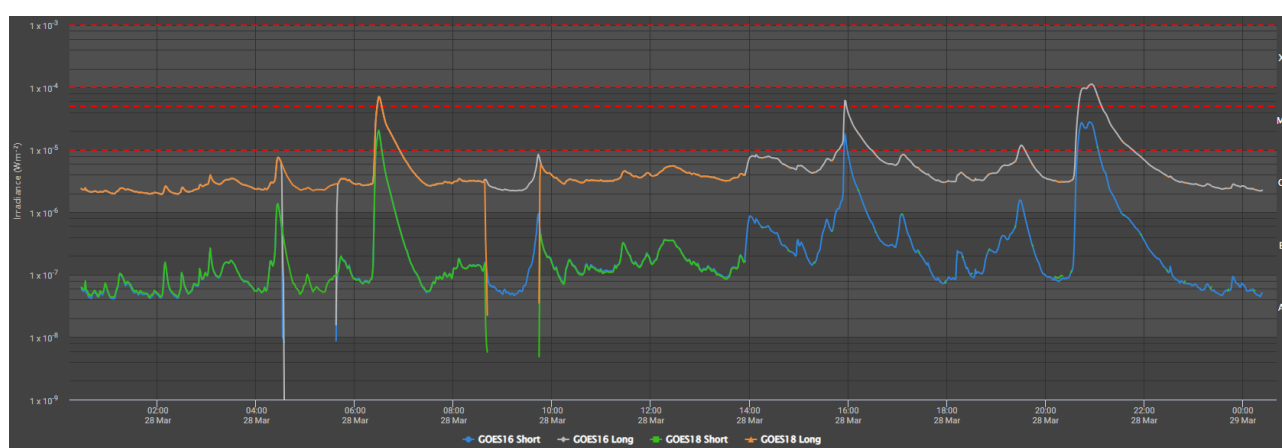
Solar activity has been High with the largest flare X1.1 peaking at 28/2056 UTC from AR3615 (Fkc/Beta-Gamma-Delta). This region has also produced 3 M-flares in the last 24 hours. There are now four sunspot regions on the visible disc, with AR3620 having faded. AR3615 is by far the largest and most magnetically complex group, with at least one delta spot, but it is becoming more difficult to assess as it approaches the limb. All remaining spots are comparatively small and simple.

AR3615 will leave the visible disc at the end of Day 2 (30 Mar), with the risk of flaring then declining through the following 24 hours. Some data from far-side sounding suggests that returning regions may rotate onto the eastern disc during the latter half of this guidance period, but it is not possible to assess these until they become visible.

M-class flare activity is expected, with a slight chance of further isolated X-class flares, most likely from AR3615. This risk then declines through Day 3 (31 Mar) as AR3615 rotates away from the limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	60	30
Very Active	R3 to R5 X Class	Yes	20	20	15	5

Figure 3: X-ray flux at GOES16 and 18, showing the recent X1.1 flare from AR3615.

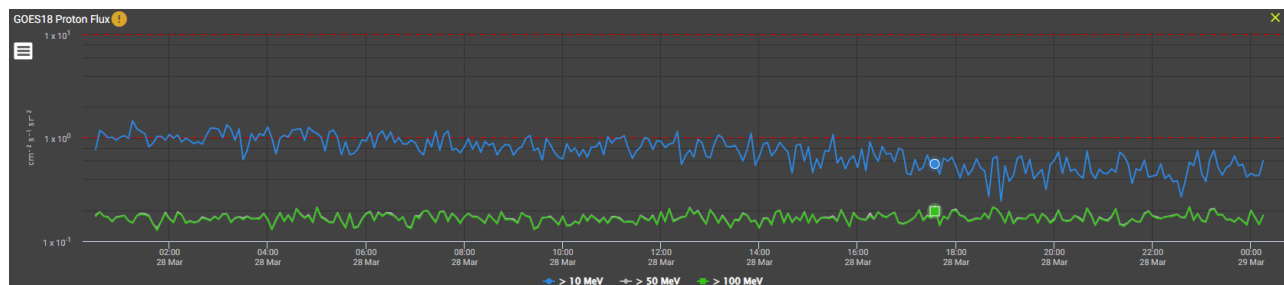


Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES18, is continuing to decline from the enhancement following the X-class flare last weekend. This is expected to soon reach background levels in the absence of further significant flare activity, with the chance of any further enhancement dominated by AR3615. However, so far there has been no proton response to the recent X1.1 flare from this region. As such, there remains a slight chance of reaching above the S1 threshold during this period, mainly due to AR3615, and although it rotates off the disc late on Day 2 (30 Mar), this risk remains until it is at least 3 days over the limb (ie through the rest of this forecast period).

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	15	15	15	15
Very Active	$\geq \text{S3}$ *	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2}\text{sr}^{-1}\text{s}^{-1}$)						

Figure 4: Proton flux at GOES18 showing a gradual decline to near background levels, with no response so far to the recent X-flare.



High Energy Electrons Event ($\geq 2\text{MeV}$):

GOES16 high energy electron flux has been mostly at background levels, briefly just touching moderate at the diurnal maximum today. The fast solar wind speeds and geomagnetic activity that occurred due to the CME last weekend are likely to have increased electron flux in the radiation belt, but the belt will have been compressed by the fast wind speeds. The BAS radiation belt model is suggesting there has been a large increase in electron flux but well below the GOES orbit. As wind speeds are now easing near to background levels, a sharp increase in flux is possible in the next couple of days, with the potential to reach high levels.

The associated 24-hour fluence is currently well below the Active threshold. It is probable that fluence will rise sharply in the next couple of days, with Active ($1\text{e}8$ integrated pfu) fluence likely. MOSWOC REFM is suggesting an increase but below the Active threshold, which may be a little low. However confidence is only moderate, as now wind speeds are near background, the longer we go without an electron response the less likely it is to occur.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	50	70	70	60
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	5	5	5

Figure 5: MOSWOC REFM forecasting a slight increase in fluence below the Active threshold, although this may be a little low.

